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Subject: Insect and Disease Activity in Hall Ranch WUI

To: District Ranger, Springerville RD, Apache-Sitgreaves NF

I recently met with Monica Boehning, Silviculturist, and Jerry Drury, Forest Silviculturist, to assess insect and disease activity in the Hall Ranch Wildland Urban Interface (WUI) project area. The primary purpose of the project is to decrease hazardous forest fuels and reduce the risk of wildfire, while maintaining or improving forest health. Other benefits include protection and enhancement of wildlife habitat, aspen stands, and recreation areas. There is a Regional emphasis to manage for goshawk habitat by applying uneven-aged silviculture treatments in ponderosa pine forest types. Since the incidence of dwarf mistletoe infection within a stand greatly influences the growth and development of trees overtime, and there is a high infestation of dwarf mistletoe in the analysis area, the prevalence of dwarf mistletoe needs to be considered when selecting sites for even- or uneven-aged management. This report includes information on the most common insects and disease causing pathogens, especially regarding dwarf mistletoe infection in ponderosa pine and its influence on stand development, and makes recommendations to minimize impacts of any pathogen, insect, or other damaging agents.

Current Insect and Disease Activity

The majority of the Hall Ranch WUI project area consists of dense stands of ponderosa pine and mixed conifer. Natural disturbances and historic processes have been altered for more than 100 years and much of the area is at increased risk of unnaturally intense wildland fire behavior and bark beetle outbreaks. There are 3 forest cover types with current/recent insect and disease activity in the Hall Ranch WUI project area: ponderosa pine, dry mixed conifer, and wet mixed conifer.

Figure 1 Dwarf mistletoe infection is common in ponderosa pine and Douglas-fir.

Dwarf mistletoe (DM) infection in ponderosa pine and Douglas-fir is common throughout the area. During site analysis walkthrough surveys, Monica and Jerry observed southwestern dwarf mistletoe infection in ponderosa pine on approximately 92% of the forested sites in the project area, Douglas-fir dwarf mistletoe in nearly 60%, and southwestern white pine dwarf mistletoe in about 20% of forested sites. Dwarf mistletoe infection intensity levels were estimated for each site in terms of percent of trees infected with dwarf mistletoe. We visited nine stands and in general found the previous estimations of DM infection to be low because all tree species were used in the calculations instead of the calculating just the percent of host type

affected for each DM species. The stands we viewed generally had greater than 50% of the host type infected, with some upwards of 80% infected. We did not find a ponderosa pine that was not infected in site 6032-19. The percentage of host trees infected with dwarf mistletoe is valuable in determining silvicultural prescriptions. Regional guidelines suggest if less than 25% of host trees are infected with dwarf mistletoe than uneven-aged treatments may be considered, but if more than 25% of host trees are infected even-aged treatments are recommended.

Over the last 5 years Insect and Disease Aerial Detection Surveyors have observed the following activity in the Hall Ranch WUI area:

2003- Ips bark beetle caused mortality in ponderosa pine and spruce bark beetle caused mortality in spruce.

2004- Aspen defoliation and mortality.

2005- Aspen defoliation and mortality and Douglas-fir bark beetle caused mortality in Douglas-fir.

2006- Aspen defoliation and mortality.

2007- Aspen defoliation and mortality.

Bark beetle activity in all forest types is currently at low levels. An outbreak of ips bark beetles in 2002-2003 resulted in widespread mortality across Arizona, including the Hall Ranch WUI project area. The outbreak was primarily the result of several native bark beetle species responding to the weakened condition of moisture-stressed, over-crowded forests. Trees on stress-prone sites were most affected. Just a few small groups of recent bark beetle caused ponderosa pine mortality were observed on the sites we visited, and most bark beetle killed trees had high levels of southwestern dwarf mistletoe. Groups of Douglas-fir mortality were observed in a couple of mixed-conifer sites but they had been dead for a couple of years and we did not observe any current Douglas-fir bark beetle activity.

Figure 2 Aspen dieback and decline.

Many aspen stands in the Hall Ranch WUI project area are in decline, marked by mortality and dieback of crowns. Similar to aspen stands across Arizona, most of the damage was caused by a series of events which included a late season frost in June 1999, a long-term drought that included an extremely dry and warm period from 2001 through 2002, and bouts of defoliation by the western tent caterpillar in 2004, 2005, and 2007. However, we observed a few stands where aspen mortality was due to impacts caused by slash pile burning.

Treatment Options to Reduce Impacts of Damaging Agents

Dwarf Mistletoe

Dwarf mistletoes are parasitic, seed-bearing plants that depend on their hosts almost completely for water and nutrients. They cause significant changes in physiological processes and structural characteristics of infected trees, which result in changes in the structure and function of forest communities[i] [ii]. Infected host trees experience growth loss, mortality, reduced seed production and viability, and a predisposition to bark beetles[iii] and root disease. Overall effects on forest structure in a site that has been infected for many generations include: increased stand openings; lower crown canopy; denser canopy due to witches' brooms; and fewer large diameter trees. Hawksworth and Geils[iv] found that more than 90% of uninfected and lightly infected ponderosa pine trees survive over a 30-year period. However, only 5% of heavily infected trees over 9 in. dbh, and none of the trees 4- to 9 in. dbh survived. Heavily infected trees are frequently attacked by secondary bark beetles.

The direct and indirect effects of dwarf mistletoe infection on its host can provide forage and nesting habitat for many species of birds[v] and mammals[vi]. Although several bird species have been observed feeding on mistletoe berries and shoots, there is little quantitative data on any except for blue grouse, which has been found to consume Douglas-fir dwarf mistletoe shoots in the fall. Insectivorous birds feed on insects that feed on the mistletoe and on bark beetles that attack weakened infected trees. Recent research has measured positive, negative, and null correlations between mistletoe related variables (e.g., the amount of mistletoe on a site and snag density) and bird species abundance in ponderosa pine sites in northern Arizona[vii]. Of the 16 bird species investigated, a positive relationship was found for 4 species, negative correlation for 5 species, and no correlation for 7 species. Three of the 4 species that were positively correlated with dwarf mistletoe infestation or snag density were cavity-nesting birds. The only foliage nesting bird with a positive relationship was western tanager. Bennetts et al.[viii] found a positive correlation between mistletoe infection and 24 bird species in mixed-conifer sites in Colorado, which had an understory shrub component absent from the study sites in Arizona.

Fire history is one of the primary ecological factors in determining the distribution and intensity of dwarf mistletoes in coniferous forests. Relatively complete burns may have a sanitizing effect on infected stands; while partial burns can lead to rapid infection of regeneration if scattered infected trees remain overtop newly established regeneration. Fire, both prescribed and natural, can have a sanitizing effect, in which heavily infected trees and the lower branches of moderately and lightly infected trees are killed by fire, thereby lowering infection levels.

Based on present understanding of mistletoe ecology, increases in host abundance over the past 150 years, and decreases in fire frequency; it can be inferred that dwarf mistletoe abundance was likely lower in the historic period[ix]. Hessburg et al. found incidence of southwestern dwarf mistletoe increased in the White Mountains from 41% to 52% in thirty years, in the commercial acres of ponderosa pine between the 1950s and 1980s[x].

The focus of managing mistletoe is to reduce the impacts of mistletoe infection on forested sites. Mistletoe management is a continuous process: new dwarf mistletoe infections take 3- to 5-years (latent period) to produce visible aerial shoots and not all infection can be detected and removed during one treatment. At least one treatment is recommended 5 to 10 years after an initial treatment, but can be accomplished during regularly scheduled silvicultural or prescribed fire

treatments.

Several features of dwarf mistletoes make them ideal candidates for cultural management[xi]:

- Dwarf mistletoes require a living host to survive. Mistletoe dies when an infected tree or branch is cut.
- Dwarf mistletoes are commonly restricted to a single host species or a group of closely related species. Non-host species can be favored during stand treatments.
- Dwarf mistletoes have fairly long life cycles and slow spread rates.
- Spread rates average only 1 foot per year. Although birds contribute to long-distance dispersal of seeds, this is rare and of little practical significance from a control perspective.
- Southwestern dwarf mistletoe-infected ponderosa pine trees are generally easy to detect due to the presence of yellow-orange shoots and witches' brooms. Trees in heavily infested stands show signs of short stature, decline, and mortality.

Managing dwarf mistletoe is difficult in stands under uneven-age management. Spread from overstory to understory trees, known as vertical spread, is rapid when seeds from infected overstory trees shower down onto younger trees. When newly infected trees in the understory begin to produce seed, lateral spread or tree-to-tree spread occurs among the young trees. Infection then progresses outward beyond the range of seeds produced from overstory trees. Researchers[xii, xiii] have measured the distance of infected seedlings from the source of overstory trees at different time intervals. In 20-year-old trees, nearly all infection is found within 35 feet of infected overstory trees. In 50-year-old trees, lateral spread of dwarf mistletoe increased the rate to nearly 80 feet in open stands and 65 feet in dense stands.

If uneven-aged treatments are to be applied in dwarf mistletoe infected stands, such as when implementing goshawk guidelines, it is best to select lightly infected stands on high quality sites. Although the presence of dwarf mistletoe in a stand is typically not related to site quality, the abundance and impacts of the pathogen on the growth and mortality of the host are strongly related to the quality of a site, soil type, and slope[xiv]. The incidence of southwestern dwarf mistletoe can be higher on dry sites with gentle slopes.

The University of Montana in conjunction with the Bureau of Indian Affairs developed the following guidelines in managing ponderosa pine stands infected with southwestern dwarf mistletoe:

Condition	**Recommended Treatment Options**
Less than 15% of stems infected	Individual Tree Selection
15-25% stems infected	Group selection, less than 2 acres
Greater than 25% stems infected	Even-aged treatment

In certain stands with low-level, patchy distributions of dwarf mistletoe infection, group selection can be used to decrease disease incidence and impacts. However, residual trees located on the edges of openings need to be mistletoe-free in order to allow disease-free regeneration to develop in the newly created openings. Since latent infections are likely along the edges of a mistletoe center, it is recommended to cut 30-40 feet beyond the edge of visible infection. Limitations on size of openings, and reserve tree requirements can hinder the success of group selection treatments in dwarf mistletoe infected stands. Followup surveys and treatments need to be conducted 5-10 years after group removals in order to check the perimeter for infected trees.

Prescribed burns can also be used to reduce dwarf mistletoe infection levels. Heavily infected trees have been shown to have reduced post-burn survival rates compared to lightly infected or non-infected trees[xv] [xvi]. Limbs located in the lower crowns of trees are killed during fire. Since dwarf mistletoe infections are generally more abundant in the lower crowns of infected trees, infection levels are decreased by the death of lower limbs.

Bark Beetles

The Southwest has a large complex of bark beetles composed of many genera and species. Although most conifers are normally attacked and killed by a single species of bark beetle, such as Douglas-fir beetle killing pockets of Douglas-fir, ponderosa pine is attacked and killed by several different bark beetles in the genera Dendroctonus and Ips. Although Dendroctonus species are the most notorious tree killers in the western United States, Ips species play a very important role in Southwestern pine forests. By selectively killing trees of certain sizes and species, bark beetles change the density, species composition, and size structure of the forest.

The majority of bark beetles are considered secondary mortality agents because they favor weakened host trees. When populations are at endemic levels, bark beetles typically attack scattered individual trees that have been weakened by lightning, disease, old age, or competition, or they are attracted to fresh logs and slash created by logging, windthrow, or snow breakage. The severity of dwarf mistletoe infection influences initial attack patterns of bark beetles on ponderosa pine[xvii] and Douglas-fir during drought events; trees with DM infection throughout their crowns (i.e. Hawksworth's dwarf mistletoe ratings of 5 & 6[xviii]) are often attacked first. As environmental factors and stand conditions favor beetle development, populations may increase rapidly and successfully attack healthy trees.

No stand hazard rating models have been developed for pine engraver beetles attacking ponderosa pine, primarily because beetle populations are driven by drought and factors leading to the creation of large amounts of slash. However, recent work, to be published soon, suggests that lower elevation sites with higher densities are more prone to ips activity. Stand hazard rating for Dendroctonus bark beetles of ponderosa pine involves measures of tree size, stand or group density (basal area), and the percent of host trees within the stand. In general, ponderosa pine stands that have an average DBH greater than 12 inches and a basal greater than 120 ft2/acre are considered at high risk to bark beetle attack[xix] [xx] [xxi]. Stands that have less than 80 square feet of basal area per acre are considered the lowest risk. In order to protect residual trees from attack from ips beetles all fresh cut "slash" (cut tree trunks, limbs, and trimming debris) should be created and treated properly to keep beetles from breeding in it and moving into adjacent residual green trees[xxii].

Aspen Mortality and Decline

Over the past several years, an accelerated decline of aspen occurred across northern Arizona following a frost event and several years of drought. In 1999, defoliation occurred due to frost damage following a severe June snowstorm. Since 2000, aerial surveyors switched from reporting acres defoliated, from which trees recovered, to acres of dieback marked by thinning crowns and mortality. One of the most severe drought events on record occurred in 2002, which resulted in additional aspen dieback and mortality across northern Arizona. Damage by the western tent caterpillar occurred in 2004, 2005, and 2007. Overall, diameter distributions showed mortality was not skewed to any particular size class, however, trees with diameters >9 inches generally took longer to die than smaller size classes. Several insects and pathogens were associated with aspen mortality but appeared to be acting as secondary agents on stressed trees. Although aspen ramet production occurred to some degree on all sites with the death of mature trees, aspen sprouts were nearly nonexistent by the summer of 2007 due to browsing both domestic and wild. Widespread mortality of mature aspen trees, chronic browsing by ungulates, and advanced conifer reproduction is expected to result in rapid vegetation change of many ecologically unique and important sites.

Browsing of aspen regeneration from large ungulates, particularly elk has been a major concern across parts of Arizona for decades[xxiii], which is very evident in the Hall Ranch WUI project area. Since the mid-1980s, forest managers have built 6½ ft tall fences around aspen regeneration to prevent elk browsing. These fences are expensive to install and maintain. Although originally intended as a temporary measure until the trees obtained sufficient height to escape browse, it was soon realized that fences need to remain for a longer period[xxiv] [xxv]. Elk damage aspen in three ways: they browse new shoots, rub saplings with antlers and gnaw or bark trees for phloem. The browsing of shoots is so prolific that it is rare to see these ramets survive more than a couple of years, and that only happens when the mature tree is still living. Barking and rubbing has been positively correlated to damage by secondary pathogenic fungi causing stem cankers and decay[xxvi] that play a role in the death of trees. Stem decay fungi contribute to stem instability as the trees grow. Permanent exclusion fences are required to allow for successful reproduction following silvicultural treatments or fire.

Recommendations

Dwarf mistletoe infection levels are high in the Hall Ranch WUI project area. Since over 90% of forested stands with ponderosa pine are infected and over 60% of sites with Douglas-fir are infected, dwarf mistletoes are expected to continue to influence the growth and development of stands overtime and methods to reduce the impacts of DM infection should be included in silvicultural prescriptions. Even-aged treatments are recommended in moderately to heavily dwarf mistletoe infected stands, while group selection can be used in lightly infected stands that are adequately stocked. Moderately infected sites can be thinned by targeting the removal of more severely infected trees while emphasizing the most vigorously growing trees. Severely infected stands should either receive a regeneration treatment, such as a shelterwood, or be deferred from treatment.

Although treatments to mitigate DM impacts can be integrated with other treatment activities like reducing a stands susceptibility to fire or insect outbreaks, uneven-aged treatments should only be considered in non-dwarf mistletoe infected or lightly infected stands on good quality sites that have well defined infection patches in which group selection can be used to target the

removal of infected trees. The 4-acre patch cut size limitation set by the Goshawk Management Guidelines is not an advisable treatment in stands that have greater than 25% infection rates, which includes many stands in the project area. In some of these stands, thinning, in which non-host trees and the less severely infected trees are retained on the site, can be the best option. The increase in space between trees helps limit spread and competition is reduced. This lessens infection levels while still allowing trees to grow to maturity. In the most severely infected sites, deferral or selection of non-host species is recommended.

Regardless of the emphasis on even-aged or uneven-aged stands, proper selection and marking of leave trees is paramount to the success of treatment. In stands selected for group selection treatments it is important to attempt to remove trees with latent infections, as described above, cutting 30-40 feet beyond the edge of visible infection. In stands receiving individual tree selection treatments, leave trees should have none to very little mistletoe infection. Monitoring for followup treatments in 5 to 10 years is recommended.

Douglas-fir beetles preferentially attack large, old trees in dense stands with a high Douglas-fir component[xxvii], and initially those with high dwarf mistletoe infections. Active stand management (thinning) provides the best long term prevention for minimizing damage by Douglas-fir beetle[xxviii], and a fuels reduction project should help to lower stand risk. However, log decks, thinning slash, and subsequent burning may pose a short-term risk to residual trees in the thinning unit or surrounding areas. Timing of thinning treatments, chipping, and placement of potential brood material in open areas should help to minimize potential impacts.

Thinning slash may pose a short-term bark beetle risk to residual trees in the thinning units or surrounding areas depending on the timing of thinning, local population of pine engraver beetles, and site and environmental factors such as site quality and precipitation. Our office recommends that slash be generated between late summer and the end of December, if possible, in order to lessen the buildup of ips bark beetles. Slash piles should be placed in stand openings as much as possible and the largest diameter slash put on the outside of the pile to promote quick drying. Tepee style slash piles with branches and small-diameter slash in the middle and the larger diameter material on the outside.

Most aspen stands in the Hall Ranch WUI have suffered some degree of dieback and decline in the past 8 years from abiotic events. It is imperative that residual stands be protected from further damage from slash pile and prescribed burning since excessive browsing by ungulates, particularly elk, is limiting the successful regeneration of aspen. Reductions in browse-pressure need to be explored.

I also wanted to mention that we did not observe any white pine blister rust in southwestern white pine in the analysis area. White pine blister rust is a non-native disease that is affecting southwestern white pine in New Mexico, but has not yet been observed in Arizona. Orange gooseberry, an important alternate host for the fungus that causes white pine blister rust, was observed in the analysis area, and wax currant was more common was more common but is not considered an important alternate host to the spread of disease in New Mexico.

If you have any questions, please give me a call at (928) 556-2075.

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